NEW JERSEY
Venturer

A Partnership to Produce the First Fully Functional Hydrogen Powered Electrical Car

New Jersey Department of Transportation
Governor Christine Todd Whitman
Commissioner James Weinstein

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FACT SHEET

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Project NJ Venturer is a unique New Jersey partnership of government agencies, technology companies and educational institutions with common and complementary interests, coming together to demonstrate the practicality of assembling and operating a hydrogen fuel cell and battery powered vehicle. The vehicle will represent New Jersey in the American Tour de Sol Road Rally in May 1999. This is the first time that a New Jersey based public/private coalition of this type has been put together with the capability of tackling an environmental project of this magnitude.

The Partners

The vehicle concept was introduced by the NJ Department of Transportation's Technology Bureau, a leader in fuel cells for transportation and electric vehicle development. The NJ DOT is the principal source for funds for the project, as well as providing manpower for project management. The New Jersey Department of Environmental Protection also has considerable involvement in the project.

Several New Jersey based technology firms are providing their expertise and design capability, labor and component equipment as in-kind contributions to the partnership. These companies include H Power Corporation (*fuel cells*), MG Industries (*gas supply),* Advanced Power Associates (*power conversion*), Neocon Technology, Inc.(*systems integrator*), Fully Independent Resident Solar Technology (FIRST), Inc. (*energy systems*), NWL Corporation (*power supply systems*),

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Diversatech Manufacturing (*metal fabrication*) and Wenzel & Company, Inc. (*communications and marketing support*).

The Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers University is providing technical and administrative support, and science and engineering teachers and students from Rutgers, Rowan University, New Jersey Institute of Technology, Burlington County College, Hunterdon County Polytech, Hunterdon Central High School and Cinnaminson High School will be participating in design and operations support.

The Event

The American Tour de Sol is an annual event organized by the Northeast Sustainable Energy Association (NESEA). This 225 mile road rally is both a competition and an educational event designed to promote the development and the use of electric vehicles. This year's tour starts in Waterbury CT on May 22, 1999, runs through parts of Massachusetts and concludes on May 29 in Lake George NY.

The Tour de Sol is a seven day educational road rally event for electric vehicles, with free public events in eight communities. The Tour showcases 50 electric, hybrid electric and solar assisted electric vehicles built by major auto and bus manufacturers, students and individuals from North America and abroad. In 1999, the rally will leave from Waterbury, Connecticut on May 22 and arrive in Lake George, New York on May 28. The New Jersey Venturer will compete in the Hybrid category, for vehicles that combine liquid or gaseous fuels with an electric drive train.

The Vehicle

The **New Jersey Venturer**, the competing NJ car, is a state-owned Solectria Force electric vehicle equipped with a fuel cell Power Generator. In choosing the Force, a retrofitted Geo Metro, the project team can rely on a safe, reliable and energy efficient four-door platform. The Force includes an AC motor/controller, drive system, regenerative braking system and battery thermal management.

To minimize costs and help pave the way for fuel cell commercialization, a five kilowatt fuel cell was chosen to optimize range as "range extender." The vehicle will be equipped with advanced nickel cadmium batteries and 12 hydrogen bottles that will take the NJ Venturer 400 miles at 45 mph.

The Fuel Cell

Hydrogen fuel cells are a leading edge technology, and the team's effort to build a fuel cell HEV (Hybrid Electric Vehicle) will be the first of its kind in the country. The fuel cell stack is composed of metal plates and platinum coated membranes. When hydrogen gas is supplied to one end of the stack and air is supplied to the other end, a non-combustive electrochemical, electricity-producing reaction occurs. The by-products of this reaction are heat and water, making the fuel cell a renewable and emission-free power source. Fuel cells have provided power and drinking water to the NASA space program.

Fuel cells offer a number of other important advantages over the internal combustion engine. They are quiet, vibration-free, and have no moving parts. As a result, they can have a life-expectancy of 30 years, which translates into about 300,000 miles.

One of the biggest drawbacks of fuel cells is their cost. Although the prices have come down in recent years, they continue to be very expensive at present.

Another challenge confronting fuel cells in vehicles is the time it takes for a fuel cell to "warm up" so that it can start producing electricity. The New Jersey Venturer has been designed to move under battery power until the fuel cell can begin generating electricity. While the current version of New Jersey Venturer uses about five pounds of hydrogen stored in 12-tanks in the rear seat, there are plans to utilize an entirely new approach to generate hydrogen in the future.

Although there might be a perception that the storage of five pounds of hydrogen in the rear seat poses a hazard, that is not so. There is less BTU energy in the hydrogen than in a gallon of gasoline. In effect, the New Jersey Venturer will be getting the equivalent of more than 400 miles per gallon of gasoline. The hydrogen used in the car comes from Canada, where it is created from hydroelectric power, making even the fuel a renewable energy source. In effect, the fuel starts as water and is broken down in molecules of hydrogen and oxygen by electrolysis. In the fuel cell the hydrogen is recombined with oxygen, creating electricity in the process as it turns back to water again. That's what makes the fuel cell such an attractive and elegant power source.

Our Long Range Goals

In addition to building a fuel cell powered vehicle to represent New Jersey in the American Tour de Sol road rally, Project NJ Venturer's longer range goals are:

- To help solve the State's air quality problems through the development and employment of advanced vehicle and power technologies.

- To provide an opportunity for students to learn about fuel cells and electric vehicles and how the integration of new technologies can help solve our future transportation and environmental challenges.
- To keep together a private/public team addressing the need for reduction of greenhouse gases through the use of zero emission technology.
- To foster the use of alternative fuels and advanced technologies consistent with the Transportation Equity Act for the 21st Century (TEA21).
- To illustrate the benefits of hydrogen as a renewable fuel having potentially broad transportation applications.
- To advance the use of electric drive systems which are inherently cleaner and more efficient than motors powered by fossil fuels.
- To develop markets for fuel cells in transportation by demonstrating their adaptability to a mobile source application.
- To demonstrate the ability to extend the range of electric vehicles beyond limitations associated with battery power.

NEW JERSEY VENTURER

Partners

H Power Corporation
Neocon Technologies, Inc.
Advanced Power Associates
MG Industries
Fully Independent Residential Solar Technology, Inc.
Diversatech, Inc.
Ford Motor Company
W. L. Gore & Associates
Wenzel & Company, Inc.
NWL Transformer
Rutgers University Center for Advanced Infrastructure Technology
Rowan University
Burlington County College
New Jersey Institute of Technology
Cinnaminson High School
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EV FACTS

History / The Environment / Energy / Economics / Legislation

History: The history of electric vehicles (EVs) is longer than that of internal combustion engines.

■ **1837**	The first electric car was built in Scotland by Robert Davidson.
■ **1892**	First production electric car created a sensation when exhibited in Chicago.
■ **1899**	Belgian-built electric car "La Jamais Contente" set a world land speed record of 68 miles per hour.
■ **1910**	Electric vehicle's first heyday. Twenty companies were producing 6,000 EVs a year. They were very popular with women because they were easy to start, clean and quiet.
■ **1928**	The introduction of the electric starter began the decline of EV production in the United States.
■ **1973**	Oil embargo and a resurgence of interest in electric vehicles.
■ **1976**	Congress passes the Electric and Hybrid Vehicle Research and Development Act over protests from Detroit and the Veto of then President Gerald Ford.
■ **1977**	Japan had 13,000 EVs in operation. Great Britain had 70,000 and the United States had 3,000 with projections of 25 million by the Year 2000. Gas prices then lowered and the electric cars declined.
■ **1980's**	The Tour de Sol started in Switzerland in 1985, the World Solar Challenge in Australia in 1987, the American Tour de Sol in 1989.
■ **1990's**	Mandates to manufacture EVs so that states can meet federal clean air requirements.

The Environment:

What are the air pollution problems facing the U.S.?

- Air pollution has been named the #1 health threat to Americans by the American Lung Association.

- Transportation is responsible for 60% - 90% of all U.S. urban air pollution.

- Nearly 100 U.S. cities fail to meet federally-established air quality standards.

- Thirty percent of greenhouse gases are attributable to transportation nationwide.

- In the Northeast, 55% of the air pollution is caused by fossil fueled transportation.

What are the transportation pollutants that contribute to poor air quality?

- Nitrous Oxides (NOx) and volatile organic compounds (VOCs) react together to create ground-level ozone, which is the main ingredient in what we see as *smog*.

- Particulate matter (PM) are small, airborne particles that contribute to respiratory diseases.

- Carbon Monoxide (CO) inhibits flow of oxygen to the brain and can be especially harmful to people with heart disease.

- Sulfur dioxide (SO2) becomes sulfuric acid, a major source of acid rain.

- Transportation produces the following percentages of overall air pollutants in the United States:

  - 30% of U.S. carbon dioxide - the greenhouse gas.
  - 76% of carbon monoxide - causes suffocation and becomes the greenhouse gas.
  - 41% of nitrous oxide (NOx) - creates ground level ozone and becomes nitric acid
  - 38% of hydrocarbons (methane and volatile organic compounds - [VOCs]) - become hydrochloric acid, a major source of acid rain.
  - 5% sulfur oxide (SOx) - becomes sulfuric acid, a major source of acid rain.
  - 23% particulate matter (PM) emissions.
  - 25% of CFC emissions (from air conditioners) - destroys outer atmospheric ozone which protects the earth from harmful ultraviolet rays.

What's the relationship between transportation and global warming?

- Burning one gallon of gasoline yields 16 lbs. of carbon dioxide (CO_2), the major greenhouse gas.

- Carbon monoxide, a major automotive emission, also contributes to the greenhouse effect.

Don't EVs just shift the pollution to the power plants?

- EVs are cleaner than gasoline powered vehicles even when taking into account pollution generated by power plants that feed electricity to EVs.

- According to the U.S. Environmental Protection Agency, given the current power plant mix, driving EVs will result in the following percentage change in each major air pollutant in the U.S.

Pollutant:	**NOx**	**VOCs**	**CO**	**SO2**	**PM10**
Change:	**-16%**	**-98.1%**	**-98.9%**	**- 52%**	**-76.1%**

How can EVs help?

- EVs can reduce overall U.S. CO_2 emissions by 28.4%.

- EVs can reduce greenhouse gases by 20.4% nationwide and 35.5% in the Northeast, according studies at the Argonne National Laboratory.

- EVs have no tailpipe emissions. Pollutants are eliminated at the street level.

- EVs can reduce air and water pollution.

Energy/Economics:

Oil & Transportation

- Transportation consumes 81% of all the oil used in this country.

- U.S. oil imports exceeded 50% in 1994 for the first time in history and continue to rise.

- The earth will run out of affordable oil in 43 - 46 years if we continue to use oil at the same rate as today. According to the U.S. Department of Energy / Energy Information Association, we use 21.7 billion barrels a year of the 1,000 billion barrels estimated in reserves.

- Oil imports are the cause of 1/3 of the trade deficit (1994-1996).

- Increased fuel efficiency standards are helpful, but gains over the past few years have been negated by increased vehicle miles traveled.

- Renewable energy is clean, creates jobs in the U.S. and keeps U.S. money at home.

Legislation:

1990 Clean Air Act

Under section 177 of the Clean Air Act (CAA), individual states retain the authority granted by Congress in the 1977 Amendments to the CAA to adopt and enforce new vehicle standards which differ from the Federal standards, as long as such standards are identical to the California standards and are adopted at least two years prior to the commencement of the model year.

Under section 110 of the CAA, each state shall adopt and submit to EPA a plan which provides for implementation, maintenance and enforcement of measures to reach the health-based National Ambient Air Quality Standard. These measures include regulations on mobile sources, such as automobiles and diesel buses, and stationary sources, such as electric utilities and manufacturing plants.

California Clean Air Regulations

To address the worst smog problem in the nation, California adopted its Low Emission Vehicle (LEV) program in late 1990. The LEV program set fleetwide automobile emissions standards for new vehicles sold in California. Commencing in 1994, the fleetwide emissions standard grows increasingly more stringent each year until 2003, the final year of the decade-long program. Four vehicle standards were established under the LEV program: Transitional LEV (TLEV); LEV; Ultra LEV (ULEV); and Zero Emission Vehicles (ZEV). Each automobile manufacturer is free to determine the vehicle mix for each year as long as the fleetwide emissions standard is achieved.

The ZEV mandate - the most controversial provision in the LEV program - required at least two percent of the vehicle sales of the seven largest auto manufacturers (GM, Ford, Chrysler, Toyota, Honda, Nissan and Mazda) to be zero emission vehicles in 1998, rising up to 10 percent in 2003. In California, two percent of the new vehicle sales of the Big 7 amounts to about 25,000 vehicles. In California, an electric vehicle will reduce emissions by 90% compared to the cleanest gasoline vehicle, even after taking power plant emissions into account.

In late March 1996, the California Air Resource Board, (CARB) repealed the ZEV mandate from 1998 to 2002, leaving only the 10% mandate in 2003 in place. In lieu of regulations, CARB has signed enforceable contracts with each of the Big 7 requiring a maximum of 3,750 advanced battery electric vehicles be introduced into the state by the year 2000.

1992 National Energy Strategy

Continued to promote fuel efficient cars by targeting:

- Improved fleet efficiency
- Development of cost-effective alternative transportation fuels
- Increased overall transportation efficiency.

The above was to be accomplished by retiring older cars and accelerating R&D on alternative fuels and cars.

1992 Energy Policy Act (EPACT)

Dictates that new car purchases of federal, state and certain private fleets must be alternative fueled vehicles. By 2003, 75% of new vehicles purchased for federal and state fleets must be alternative fueled vehicles. The total market share of mandated Zero Emission Vehicles must reach 10% by 2003 in California (175,000 vehicles), New York (70,000 vehicles) and Massachusetts (25,000 vehicles).

The Northeast

All Northeast States, with the exception of Vermont, are currently in violation of the National Ambient Air Quality Standard for Ozone and, in addition, most states have one or more carbon monoxide non-attainment areas. (Automobiles contribute from 50% to 75% of the pollutants in the Northeast.)

A February 1995 ruling by the USEPA requested by the Ozone Transport Commission (OTC), required Northeast states to resubmit State Improvement Plans (STPs) within one year to include California fleetwide emissions standards without the ZEV mandate. New Jersey has adopted the "OTC LEV" program.

Glossary of Terms

Battery: a device which converts chemical energy into electrical energy.

Compressed Natural Gas (CNG): a carbon-based gas used as an alternative fuel in vehicles. It is usually found in association with oil, composed primarily as methane.

Efficiency: ratio of work done to energy consumed; usually expressed as a percentage. A well-tuned gasoline-powered vehicle is 15% to 20% efficient. An electric vehicle is over 80% efficient.

Electric Vehicle (EV): a car, bus, van or motorcycle with an electric motor which is powered by electricity stored in a battery, flywheel or fuel cell.

Ethanol: a liquid-carbon based alcohol used as an alternative fuel in vehicles. It can be produced by fermenting corn. Fuel tanks must be 50% larger than a gasoline tank to achieve similar range.

Flywheel: a mechanical device that stores energy by spinning an object at very high speeds.

Fuel Cell: a unit that converts gaseous fuel, such as hydrogen or methanol directly to electricity. Fuel cells are about 2.5 times more efficient than an internal combustion engine.

Greenhouse Effect: a temperature increase which results from high energy passing through a material such as glass and changing to heat energy which cannot escape. Atmospheric gases such as carbon dioxide or methane cause the same effect.

Hybrid Electric Vehicles (HEVs): vehicles that have both an electric motor and a fossil fuel-powered internal combustion engine or a fuel cell on board.

Methane: a carbon-based gas used as an alternative fuel in vehicles. It is produced by landfills or other biomass.

Methanol: a liquid carbon-based alcohol fuel used as an alternative fuel in vehicles. It can be produced from natural gas, coal or wood. Fuel tanks must be twice as large as gasoline tanks to achieve a similar range.

Photovoltaic Cell (PV): a device that converts light directly into electricity. Photovoltaics produce direct current or DC current and are sometimes referred to as solar cells, photovoltaics or PVs.

Renewable Energy: any source of energy which is replaced in a relatively short period of time, sometimes defined as a person's lifetime or less.

Solar Energy: energy which comes directly from the sun. Solar energy can be used to heat water, heat air or generate electricity. Solar energy is also the source of wind power, hydroelectric power, animal and human energy.

Solar Vehicle, Or Solar Assisted Vehicle: an electric vehicle whose batteries are charged wholly or partially by electricity produced from photovoltaic cells which are installed on the car.

Solar Electricity: electricity which is produced by light from the sun. The photovoltaic cell is the mechanism used for the electrical generation.

Sustainable: sustainable practices are those which meet the need of the present generation without compromising the ability of future generations to meet their needs. Sustainable energy sources are those that do not deplete resources or pollute the earth. Sustainable transportation systems are those that do not deplete resources or pollute the earth. Sustainable transportation systems are those that are powered by sustainable energy sources.

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